DAMAGING COLD WAVE OF MARCH 23–31, 1955

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1. INTRODUCTION

The cold wave of March 23–31, 1955, was typical of Arctic outbreaks that occur frequently during the winter season, but was phenomenal for the early spring. The severity of this freeze is evidenced by the many minimum temperature records (see table 1) that were broken as the cold air moved south and east across the United States, and is of special interest because of the extensive freeze damage to crops and shrubbery.

One of the causes of the great damage was the warm weather of the previous week. Departures of average temperature from normal for the weeks ending March 21 and 28 respectively are shown in figure 1C and D of the preceding article by Winston. For the week ending March 21, the Southern, Central, and Southeastern States experienced temperatures above normal. This warm weather permitted the fruits and flowers to advance rapidly, but the early beginning was severely checked as the cold air extended eastward to the Atlantic Coast.

The purpose of this paper is to discuss the weather sequence that was associated with this severe cold wave.

2. THE ARCTIC HIGH OVER CANADA

The synoptic weather picture as it existed on March 23, at 1500 GMT is presented in figure 1. The 1000-mb. chart shows a large complex Low dominating southeastern Canada with a trough from the Great Lakes to a weak cyclonic circulation near St. Cloud, Minn. The High centered over Georgia was a remnant of a weak surge of cold air earlier in the week. The Arctic High centered just north of Alberta, Canada, with a ridge to the east of the Continental Divide, was the surface reflection of the very cold air dome that was destined to push southeastward over the United States.

The 1000- to 500-mb. thickness of 15,800 feet at Edmonton, Alberta, and northward was 400 feet thinner, i. e., colder, than the four-year (1947–1951) March minima as shown by Sutcliffe [1]. From the cold High in Canada to the front near Topeka, Kans., there existed 2,000 feet of 1000- to 500-mb. thickness gradient, indicating the great magnitude of the cold air poised and waiting to move south.

The 500-mb. chart for March 23, 1500 GMT (fig. 1b) indicates moderately strong westerlies throughout the United States with a broad cyclonic flow. There were two closed low cells in southern Canada, one near Montreal, the other near Edmonton, and a sharp ridge line extending inland along the Canadian-Alaskan border from a broader ridge just off the western Canadian coast. A sharp trough in the central Pacific with a closed Low at 47° N., 160° W., completed the 500-mb. picture.

The stagnant cold Low over Alberta at 500 mb. superimposed on the surface High made ideal conditions for the development of extremely cold temperatures. The

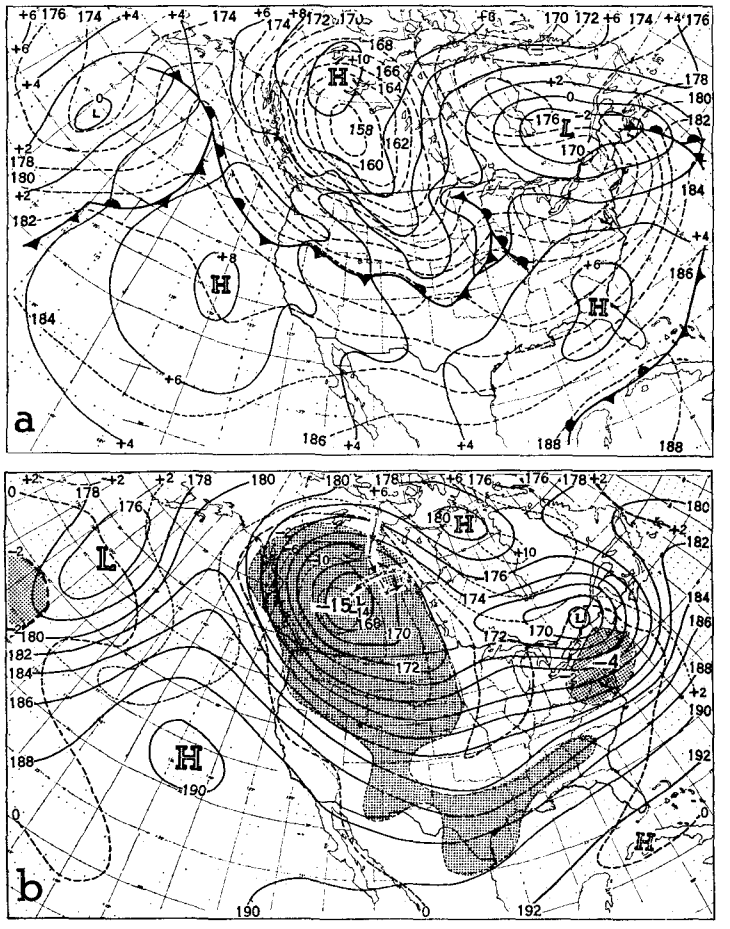

FIGURE 1.—1500 GMT, March 23, 1955. (a) 1,000- to 500-mb. thickness lines (dashed) superimposed on 1,000-mb. contours (solid) and surface fronts. (b) 1,000- to 500-mb. thickness departure from normal (dashed) superimposed on 500-mb. contours (solid) with negative departure of 200 feet or more shaded. All isopleths are labeled in hundreds of feet. Track shows previous 12-hour positions of low center.

—1400-ft. departure from normal 1000- to 500-mb. thickness values over Edmonton were testimony of the extreme nature of the situation.

3. THE ARCTIC HIGH MOVES SOUTH

A deep 500-mb. Low, associated with a deepening surface system in the western Pacific on March 23, moved to the eastern Aleutian Islands by March 25. The strong southwesterly flow in the southeast quadrant of this system may be seen in figure 2. It was also evident by this time that the westerlies would require the central Pacific trough to remain cut off.

Confluence over the area near ship PAPA (50° N., 145° W.) appeared to be building the eastern Pacific ridge into western Canada, joining it with the warm westward-moving Canadian High. The result of this was increased northerly flow over western North America, which in turn could direct the cold air, then in the North Central States, farther south and east. Surface minimum temperatures over the northern United States had started to reflect the intensity of this cold air by the morning of March 25 with Helena, Mont., recording —30° F., the coldest March temperature ever recorded there.

As the weak Low over Iowa, March 23, 1500 GMT, moved northeast through the St. Lawrence Valley, the associated cold front moved east and south. During the 48 hours that elapsed between figures 1 and 2, the Arctic High became more cellular and the first indication of a break-off cell was in evidence near Great Falls, Mont.

The center of the cold air, as indicated by the closed 1000- to 500-mb. thickness line near Edmonton on March 23, had moved to Huron, S. Dak., by March 25, with only slight modification as evidenced by the central thickness value. In this center the 1000- to 500-mb. thickness remained in excess of 1,400 feet thinner than normal (figs. 1b and 2b) during the initial southward movement of the cold air, although the actual thickness indicated air mass warming.

The 1000- to 500-mb. thickness values shown in figure 2a are of record-breaking magnitude over South Dakota, Nebraska, and Iowa. These values are 400 to 600 ft. lower than the March minima prepared by Sutcliffe

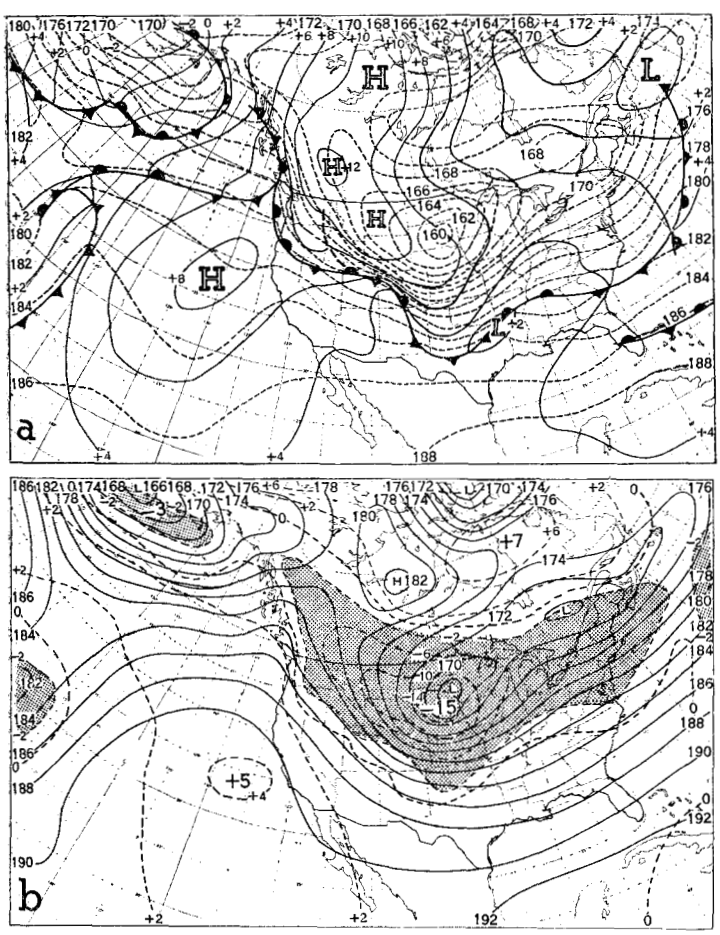

FIGURE 2.—1500 GMT, March 25, 1955. (a) 1,000- to 500-mb. thickness lines (dashed) superimposed on 1,000-mb. contours (solid) and surface fronts. (b) 1,000- to 500-mb. thickness departure from normal (dashed) and 500-mb. contours (solid) with negative departure of 200 feet or more shaded. All isopleths are labeled in hundreds of feet.

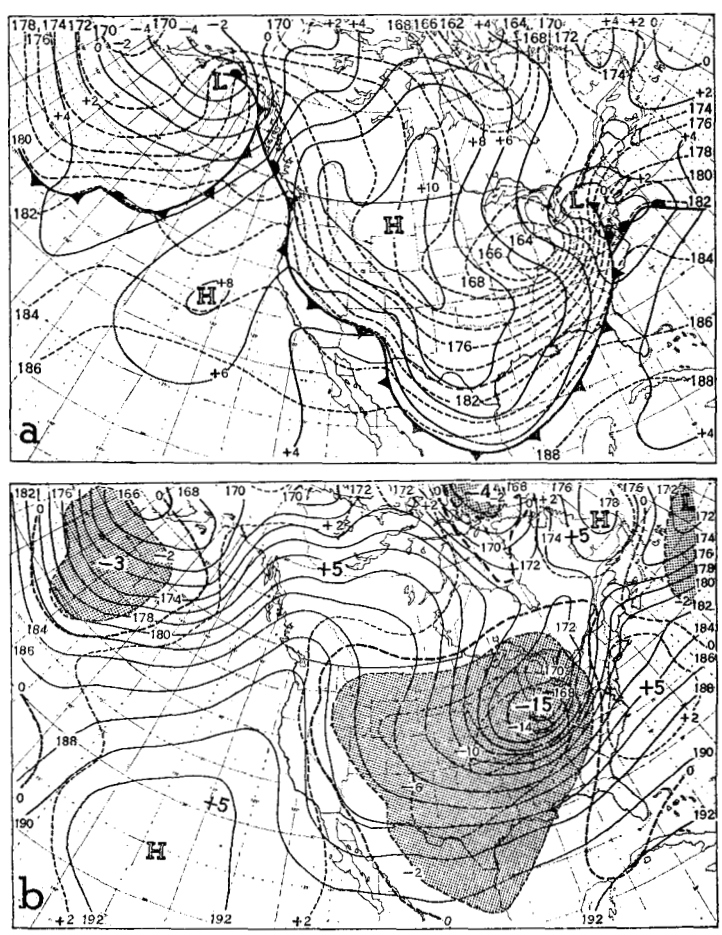

FIGURE 3.—1500 GMT, March 26, 1955. (a) 1,000- to 500-mb. thickness lines (dashed) superimposed on 1,000-mb. contours (solid) and surface fronts. (b) 1,000- to 500-mb. thickness departure from normal (dashed) and 500-mb. contours (solid) with negative departure of 200 feet or more shaded. All isopleths are labeled in hundreds of feet.

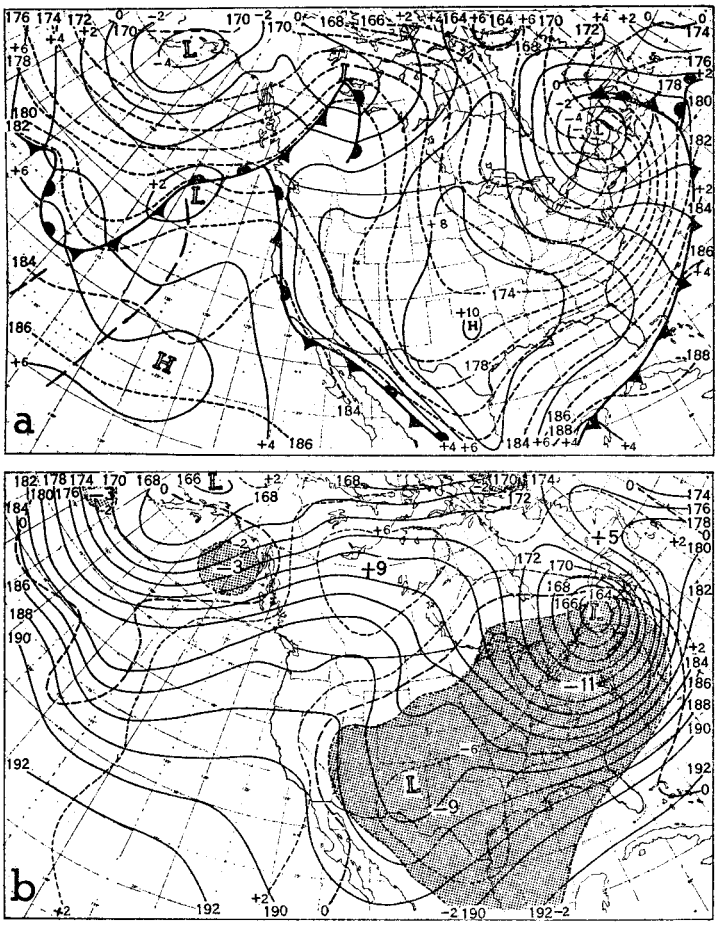

FIGURE 4.—1500 GMT, March 27, 1955. (a) 1,000- to 500-mb. thickness lines (dashed) superimposed on 1,000-mb. contours (solid) and surface fronts. (b) 1,000- to 500-mb. thickness departure from normal (dashed) and 500-mb. contours (solid) with negative departure of 200 feet or more shaded. All isopleths are labeled in hundreds of feet.

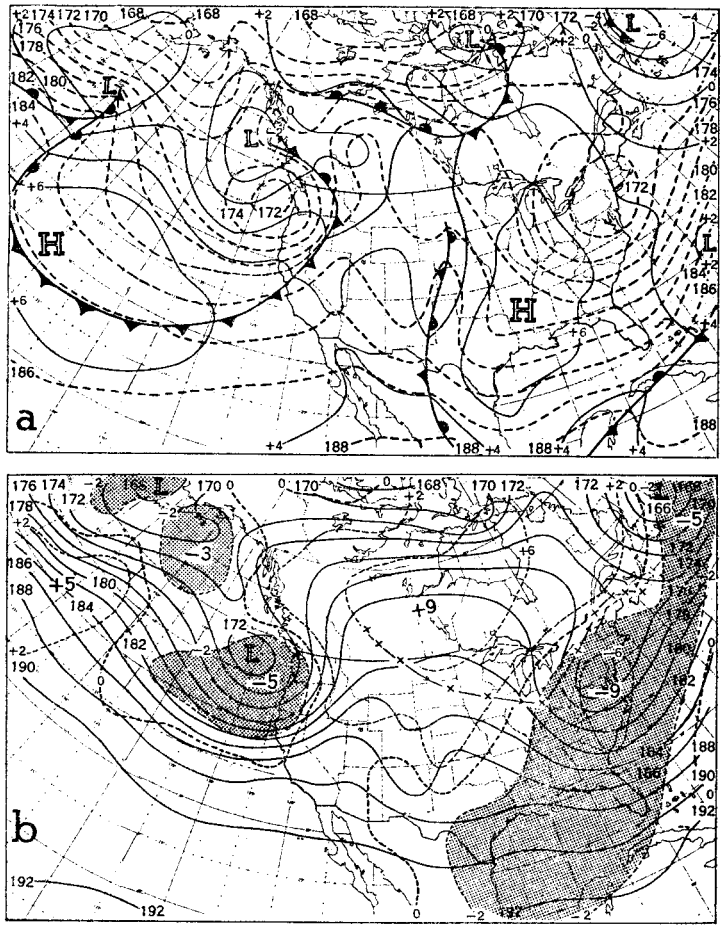

FIGURE 5.—1500 GMT, March 29, 1955. (a) 1,000- to 500-mb. thickness lines (dashed) superimposed on 1,000-mb. contours (solid) and surface fronts. (b) 1,000- to 500-mb. thickness departure from normal (dashed) and 500-mb. contours (solid) with negative departure of 200 feet or more shaded. All isopleths are labeled in hundreds of feet. Track shows previous 12-hour positions of low center.

[1] and shown in figure 6. The departure from normal 1000- to 500-mb. thickness lines on figure 2b clearly show the inverted thermal picture with the Canadian area 600 ft. thicker (warmer) than normal and the north-central United States 1,400 ft. thinner (colder) than normal for March.

By March 26, 1500 GMT (fig. 3), the cold air was well into the United States. The center of the cold air mass, as shown by 1000- to 500-mb. thickness lines, remained in the northerly flow, between the surface Low and High centers, as it moved southeastward from Huron, S. Dak., to Rantoul, Ill. From the crossflow of the 1000-mb. contours and the 1000- to 500-mb. thickness lines we get a good graphical picture of the cold-air advection. From Atlanta, Ga., to Oklahoma City, Okla., there was a gradient of 210 feet at the 1000-mb. level which produced an average northerly flow component of 50 knots. With this strong northerly flow almost perpendicular to the 1000- to 500-mb. thickness lines, there is little wonder that the cold air penetrated deeply into the Gulf Coast States.

By March 26, 1500 GMT, the previously anticipated merger of the eastern Pacific ridge and the Canadian High at 500 mb. was complete, and had produced greater wave amplitude at this level. The west and northwest winds over the Rocky Mountains on the 24th had veered to north coincident with the building ridge. The northerly upper air flow over the Rocky Mountain States served to drive the surface cold air deep into Texas as the main mass of cold air spread eastward.

The strengthening of the ridge in the eastern Pacific was reflected in the 1000- to 500-mb. thickness departure from normal. On the 25th there was an area of positive departure from normal near California and another in northwestern Canada. By March 26, 0300 GMT (not shown), these two areas of positive departure from normal

had merged in the vicinity of Annette, Alaska, and by March 26, figure 3b, the combined area had expanded and was 400 feet above normal. This type of change frequently occurs in advance of a deepening cyclone as it moves into the Gulf of Alaska, and alert forecasters have learned that it is a critical area for forecasting weather over much of North America.

By March 27, 1500 GMT (fig. 4a), the 1000-mb. High was centered near Fort Worth, Tex., with a ridge along the east coast of Mexico that thrust the cold air as far south as Mexico City. The eastward thrust of the High extended the cold air along the Gulf Coast and into the Carolinas with many new minimum temperature records. New Orleans reported the latest spring freeze since 1894 and the lowest temperature for so late in the season for 82 years of record [2]. In 24 hours the 1000- to 500-mb. thickness over the Carolinas changed from 200 ft. above normal to 200–700 ft. below normal, and Cape Hatteras cooled 1,050 ft.

TABLE 1.—*Record-breaking minimum temperatures at selected stations along the path of the Arctic air mass that moved south and east over the United States, March 23–31, 1955*

Location	Date, March 1955	Minimum temperature (° F.)	Remarks
Helena, Mont.	25	−30	Coldest on record for month of March.
International Falls, Minn.	27	−15	Broke record.
Denver, Colo.	26	−4	Lowest ever recorded so late in spring.
Missoula, Mont.	26	−3	Do.
Omaha, Nebr.	26	0	New record.
Des Moines, Iowa.	26	2	Previous record for this late in season 4° on 25th.
Peoria, Ill.	26	5	Lowest ever recorded so late in spring.
Kansas City, Mo.	25	9	Previous record so late in season, 12° in 1894.
Indianapolis, Ind.	26	10	Broke record.
Greenville, N. C.	27	16	Previous lowest temperature so late in spring, 27.4° on April 15, 1907.
Muscle Shoals, Ala.	26	18	
Memphis, Tenn.	26	18	Lowest temperature for so late in season.
Birmingham, Ala.	27	18	Previous record for so late in season, 29° in 1937.
Wichita Falls, Tex.	26	19	Lowest temperature ever recorded so late in spring.
Little Rock, Ark.	26	19	Lowest ever recorded so late in season.
Raleigh, N. C.	27	20	Broke record.
Augusta, Ga.	27	21.6	Lowest temperature for so late in the spring.
Waco, Tex.	26	25.0	Do.
Charleston, S. C. (WBAS)	27	26	Minimum temperature records established for so late in season.
Columbia, S. C.	28	26	Lowest ever recorded so late in spring.
Savannah, Ga.	27	26.4	Do.
Del Rio, Tex.	28	27	Do.
Charleston, S. C. (WBO)	27	28	Minimum temperature records established for so late in season.
New Orleans, La.	27	30	Coldest temperature experienced in city since February 1951.
Lake Charles, La.	27	31	New record for so late in spring.
Laredo, Tex.	28	35	Lowest for so late in spring.

The charts of March 29 (fig. 5) show the final stages of the cold wave. The building ridge of the eastern Pacific moved inland over the Pacific Coast as the cold air continued eastward. The departure from normal 1000- to 500-mb. thickness over western Canada continued to grow, increasing from 400 ft. above normal on the 26th, to 800 ft. above normal on the 27th, with the 800-ft. above normal area expanding slightly by the 29th. With the shift of the ridge onshore, temperatures began to return to normal over the United States.

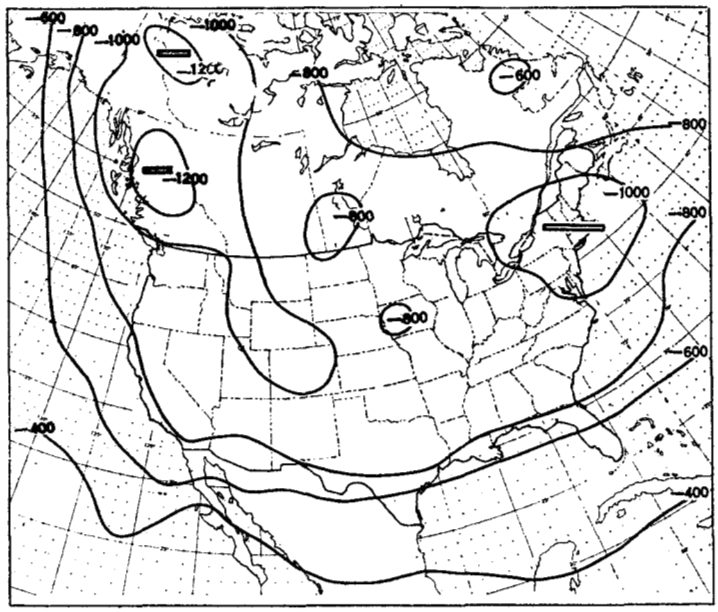

FIGURE 6.—Departure from normal of the southern (minimum) envelopes of 1,000- to 500-mb. thickness for March. (1947–51 data after Sutcliffe [1]).

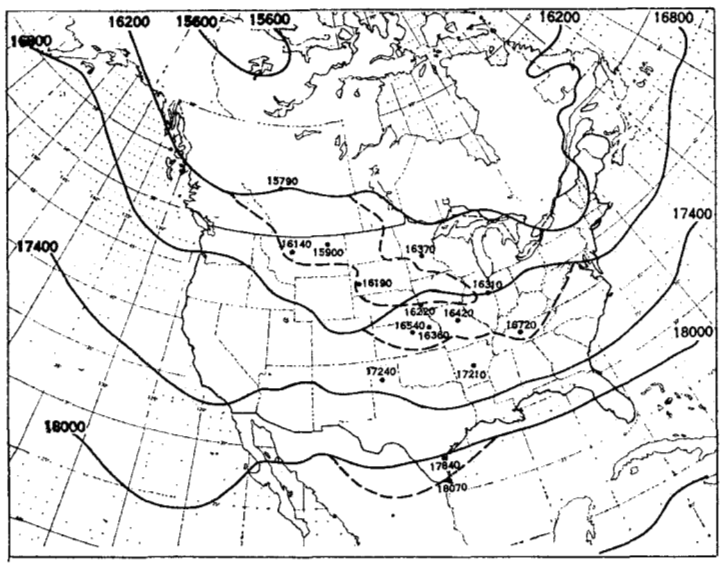

FIGURE 7.—Southern (minimum) envelopes of 1,000- to 500-mb. thickness for March (1947–51 data, after Sutcliffe [1]) with dashed lines showing extensions of the envelopes demanded by thickness values recorded in cold wave of March 1955.

4. SOME NEW RECORDS

The records presented in table 1 were established as the cold wave moved across the country. Column 3 is arranged in order of ascending values of minimum temperatures. The magnitudes of these extremes are evaluated in the remarks.

Figure 6 presents the departure from normal of the southern (minimum) envelopes of 1000- to 500-mb. thickness for March (1947–51) after Sutcliffe [1]. A comparison of these

values with the departure from normal 1000- to 500-mb. thickness values of this study, as shown by dashed lines in figures 1b through 5b, clearly points out the intensity of this cold outbreak. The solid lines of figure 7 show the minimum envelopes of the 1000- to 500-mb. thickness for March 1947–51 (after Sutcliffe) and the dashed lines show the new minimum envelopes established by this cold wave late in March.

ACKNOWLEDGMENTS

We have drawn quite freely on the *Weekly Weather and Crop Bulletin* for reported record temperatures. Acknowledgment is made to senior members of NWAC for review and suggestions.

REFERENCES

1. R. C. Sutcliffe, *Charts of Maximum and Minimum Thickness Lines 1000/500 mb., Northern Hemisphere 1947–1951*, Meteorological Office, Dunstable, England, 24 charts. (Reproduced by U. S. Air Weather Service, Washington.)
2. U. S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. XLII, No. 13, March 28, 1955.

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